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SUBJECT: Dust and Drinking Water Sampling Protocols for Pb Exposure

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On the question of protocols for sampling dust and drinking water for the purpose of assessing Pb exposure, I have the following observations.

A dust sample, whether household or street/playground dust, is seen as intermediate in the exposure pathway between soil (or another major source such as Pb-based paint) and the point of ingestion, whether by hand-to-mouth activity or incorporation with food during cooking. It is widely believed that, for children 2-4 years old, the household dust ingested by hand-to-mouth activity is the most significant route of Pb exposure. It is also believed that most of the mass of dust in the house comes from exterior soil. Without the intermediate household dust link between soil and blood Pb, many studies show only a weak association between neighborhood soils and blood Pb distributions. Consequently, sampling protocols that take these factors into consideration are the most valuable in establishing this intermediate estimate of exposure.

The correct household dust sample should measure both the concentration of Pb in the dust and the amount of dust on typical surfaces subject to contact by children. This is most easily taken as a dry vacuum sample over a prescribed area, collected in a manner that the total mass of dust collected can be measured. Thus the measure of dust can be expressed as $\mu g$ Pb/$m^2$ or $\mu g$ Pb/g dust. Studies that take a wet sample do not measure the total mass of dust and are therefore limited to expressing the results as $\mu g/m^2$. Because the ingestion rate of dust is expressed as g/day (typically 0.1 g/day, but highly age dependent), the conversion from $\mu g$ Pb/$m^2$ x g/day = $\mu g$/day is not possible.

Even worse is the protocol that calls for sampling dust from vacuum cleaners. There is no consistency between households on vacuum cleaner type, thus no guarantee that similar dust samples have been taken. A new vacuum cleaner with a clean bag is often so powerful that particles less than 1 $\mu m$, typically high in Pb, are forced right through the bag. A weak vacuum cleaner with a nearly full bag would collect a completely different sample. Likewise, vacuum cleaners are used to clean surfaces that may not be strongly associated with child exposure. Furthermore, there is no measure of either the area sampled or the surface loading of the household. Because of the larger mixtures of fabric fibers, insect parts, and other dust components typical of rugs and upholstered furniture, the vacuum cleaner bag sample cannot be considered typical of the window sill or other hard surface more common to childhood exposure.

Exposure to Pb in drinking water needs to be assessed in terms of some combination of water that is consumed from fully flushed taps and from taps that have been unused or stagnant for sufficient time to approach equilibrium in the accumulation of Pb by dissolution from the interior surfaces of the distribution system. It is usually possible to estimate the fully flushed drinking water concentration, which is typically less than 5 µg/L or ppb. The fully stagnant sample is unique to each home and cannot be predicted by any observation except direct measurement.

The question arises concerning the length of time to achieve full stagnation. Ideally, this should be overnight, as this would usually represent the maximum period of disuse of the system. Some studies have shown that a 4 hour stagnation time is nearly equivalent to overnight stagnation. A stagnation time of less than 4 hours can generate erroneous and often misleading data. There would be no way to estimate the Pb concentration at full stagnation, the data are not representative of a mixture between fully flushed and full stagnation, and the data would be of no value for comparison to other studies that measured full stagnation in a more traditional manner.

Finally, it is worth noting that most studies of childhood Pb exposure can benefit from compatibility with the Uptake/Biokinetic model for Pb. It is virtually impossible to sample every source of exposure in a child's environment. The model is an effective tool to supplement the experimental data collected during a study with typical or best estimate data for exposure to food Pb or air Pb. However, unless data on dust and drinking water are collected in a manner to avoid the pitfalls above, the model will be of little use in the assessment of the total exposure of the sample population.